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Strip intercropping systems

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Abstract
Economic, environmental, and biological concerns prompt the search for alternative, sustainable, agricultural production systems. Farmers need cropping systems that reduce negative impacts on the environment while maintaining or even improving farm profitability

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Agronomy, Cover crops, Double crops, Strip cropping

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COMPETITIVE GRANT REPORT
88-05 and 88-06

Strip intercropping systems

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Budget
$76,412 for year one
$62,790 for year two
$62,790 for year three

Goals

Economic, environmental, and biological concerns prompt the search for alternative, sustainable, agricultural production systems. Farmers need cropping systems that reduce negative impacts on the environment while maintaining or even improving farm profitability.

The traditional corn-soybean cropping rotation, and to a lesser extent continuous corn, have proven the most profitable systems to date for Iowa agriculture. But income—and production costs—must be balanced with environmental costs. Specifically, the nitrogen (N) needs and soil erosion losses of these practices prompt the search for more sustainable approaches to raising these crops.

Narrow-strip cropping systems may address environmental concerns and offer the farmer economic advantages. This study focused on evaluating the following aspects of narrow-strip cropping systems:

- effect of strip positions on yield (because border rows of tall crops benefit from the extra sunlight they receive);
- legume and N management effects on the succeeding corn crop;
- how tillage systems affect yields;
- how tillage and weed management approaches affect prevalent weed species and their populations;
- how weed management affects corn's response to N fertilization; and
- narrow-strip cropping's economic potential compared to monocropping practices.

Approach

This project comprised seven separate experiments. Five were conducted at ISU's McNay Research Center near Chariton, Iowa, in 1988; one was established at the Northeast Iowa Research Center near Nashua in 1986 and the other, at the Tom Frantzen farm near New Hampton, Iowa, began in 1989. At McNay and on the Frantzen farm, researchers integrated three or four crops, always including corn; at the Northeast location, they used two or three.

At each site, all the crops in the cropping system exist in each experimental unit. Strip widths vary by locations; at the Northeast Center, they are 15 feet (ft) wide and accommodate six 30-inch (in.) rows. At McNay, strips are 12.5 ft wide with five 30-in. rows, and on the Frantzen farm, where ridge tillage is used, the 12.5-ft strips each have four 38-in. rows. Each experiment studied a unique aspect of the system, although crops were managed similarly across experiments. Researchers measured crop yields on all experimental plots.

Experiment 1: The contiguous strips of corn, soybeans, and oats or alfalfa underwent three separate tillage systems (no-till, reduced till, and intensive tillage) to determine relative effect on yield according to each crop's positions. Here, as in experiment 2, researchers measured soil water content by depth to determine its effect on, and response to, the narrow-strip cropping system.

Experiment 2: The same crops and tillage systems as in Experiment 1 underwent three weed control methods: broadcast applications of herbicide; banded applications of herbicide, and no herbicides. Cultivation controlled weeds when necessary.

Experiment 3: Alfalfa N fixation and contribution to the succeeding corn crop were evaluated for three management alternatives—directly seeded alfalfa, alfalfa seeded with a companion crop of oats, and spring seeding (drilling) of alfalfa into an established winter wheat stand.

Experiment 4: The same crops as in experiments 1 and 2 underwent reduced tillage, and researchers again compared the three weed control methods. In addition, they measured the alfalfa N contribution as well as weed species and populations.

Experiment 5: This work focused on determining the effect of the three tillage systems on alfalfa's N contribution to the succeeding corn crop.

Experiment 6: (Northeast Iowa Research Center)—Herbicides were broadcast in row-crop plots. Researchers evaluated how corn interacted with other crops at the borders by monitoring harvest of row crops row-by-row and harvest of oats and small-seeded legumes by position.

Experiment 7: (Frantzen farm)—This location provided the constraints of a commercial production operation under ridge tillage. Each strip contained four relatively wide corn or soybean rows or 20 oat rows. Various corn hybrids were used in two procedures: one in which the rows were oriented east to west and another in which rows were positioned northeast to southwest. The results, which correspond to strip position, were averaged over the hybrids.

Findings

Across the seven experiments, corn and oat yields tended to be highest on the strip edges and lowest in the strip middles under favorable weather conditions. Soybean yields, on the other hand, tended to be lower on the edges than in the middles. Under dry conditions, lower yields occurred next to oats; under wet conditions, lower yields occurred next to corn. In general, corn and oat yields responded well to the narrow-strip system; soybean yields did not.

Drought conditions adversely affected legume production and establishment. Though alfalfa was predominantly used in this study, its expense and consistent overwintering tendency (which can compromise the establishment of the subsequent crop) prompt the researchers to seek a more appropriate legume.

Under dry conditions, no-till significantly improved yields over reduced and conventional tillage. Under wet conditions, however, tillage practice seemed to matter less, although no-till produced the lowest yields under the wet conditions—probably in part because of wet, poorly drained soils. In fact, during the 1989 drought, no-till conserved enough soil water to produce positive border effects in crop yields; other tillage systems did not. Averaged over the four years of the project, the reduced tillage system resulted in the best production.

Under good weather, the narrow-strip cropping system appears to offer greater economic returns than its conventional counterpart.

Fertilizer N applied in the border corn row seems to be used by that row, alleviating researchers' concerns that adjoining strips would compete for the nutrient.

Although supplemental N treatments did not affect weed populations, herbicide treatment and crop had a significant impact. In general, broadcast herbicides resulted in fewer weeds than did banded applications. Untreated crops, regardless of fertilizer treatment, had the greatest number of weeds. Corn and soybeans receiving a broadcast herbicide had fewer weeds than the same crops under a banded herbicide treatment.

Weed management strategies are lacking for oats and alfalfa, which had consistently more weeds than corn and soybeans, regardless of herbicide treatment.

Weed populations differed significantly by tillage treatment. Conventional tillage had the lowest weed population; reduced and no-till treatments were very similar when averaged over herbicide treatment and crops.

Finally, while environmental conditions differed significantly during the four years of the project, *weed populations stabilized after the first year of the project.* Still, a gradual buildup of weed seeds could cause problems if allowed to go unchecked.

Implications

This research indicates that narrow-strip cropping is a viable alternative to large-field production schemes. Although this system offers greater economic potential, it requires different management skills that will help to reduce fertilizer nitrogen requirements, pesticide applications, and soil erosion.

Unlike some alternative systems that simply favor the environment and not necessarily the farmer, this practice is more likely to be adopted by farmers because of the potential for greater profit. Thus, it is truly sustainable.

This greater production potential suggests that farmers of small or intermediate-size operations can more easily compete with farmers of large operations. Simply stated, *increasing production without increasing acres farmed or inputs used means more profit per acre.*

This work will address next the use of alternative small grains in this narrow-strip cropping system. The market for oats is finite; wheat may be a viable candidate because the market for it is much greater and less responsive to fluctuations in supply.

Researchers must also identify a legume that contributes N without possessing a strong overwintering tendency in order to make the system useful to the average farmer. In the meantime, the system has demonstrated very good soil erosion control. Still, only when this system's soil conservation characteristics have been quantified will farmers be given credit—via government programs or other avenues—for adopting it.

The Leopold Center's interdisciplinary cropping systems issue team, one of six Center-initiated and supported research teams, is using data generated from this competitive grant study to conduct a more thorough economic analysis of narrow-strip cropping.

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Oats, soybeans, and corn are a viable combination for the narrow-strip cropping system.